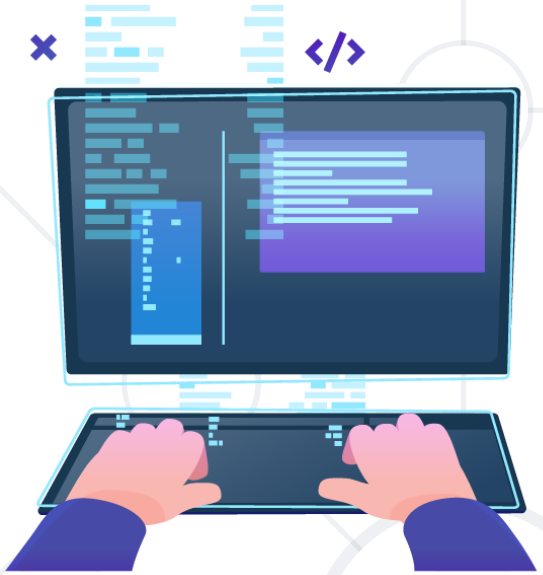
Syntax, Functions and Statements

Operators, Parameters, Return Value, Arrow Functions



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Introduction to JavaScript

Definition, Execution, IDE Setup

What is JavaScript?

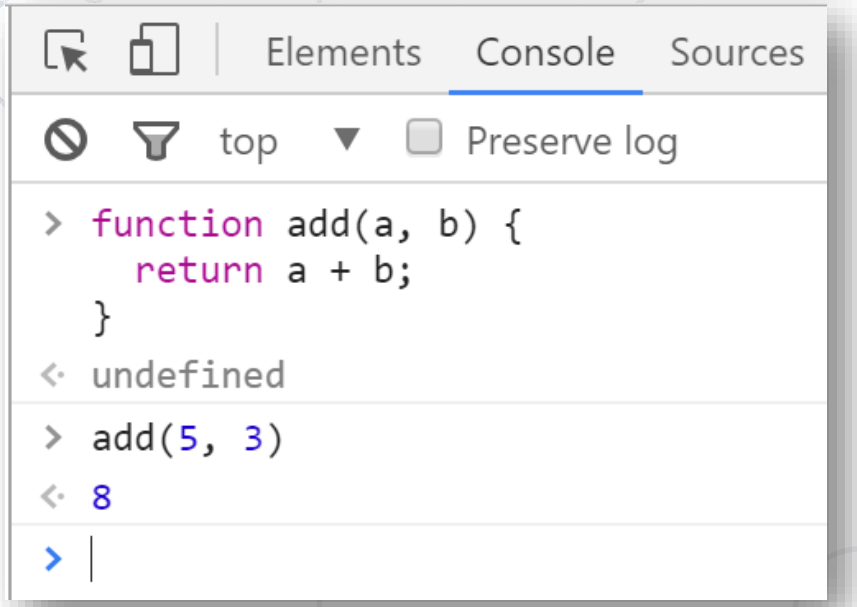
- JavaScript (**JS**) is a **high-level** programming language
  - One of the **core technologies** of the World Wide Web
  - Enables **interactive** web pages and applications
  - Can be **executed** on the **server** and on the **client**
- Features:
  - C-like **syntax** (curly-brackets, identifiers, operator)
  - **Multi-paradigm** (imperative, functional, OOP)
  - Dynamic **typing**

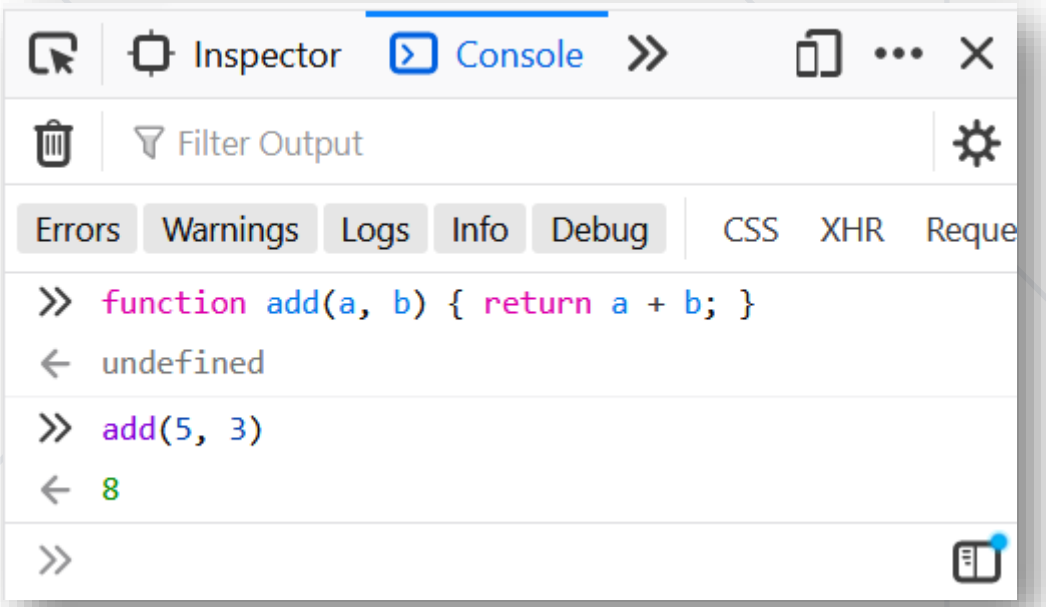
Dynamic Programming Language

- JavaScript is a **dynamic programming language**
  - Operations otherwise done at **compile-time** can be done at **run-time**
- It is **possible** to change the **type** of a variable or add new properties or methods to an object **while** the program is **running**
- In **static programming languages**, such changes are normally **not possible**

Chrome Web Browser

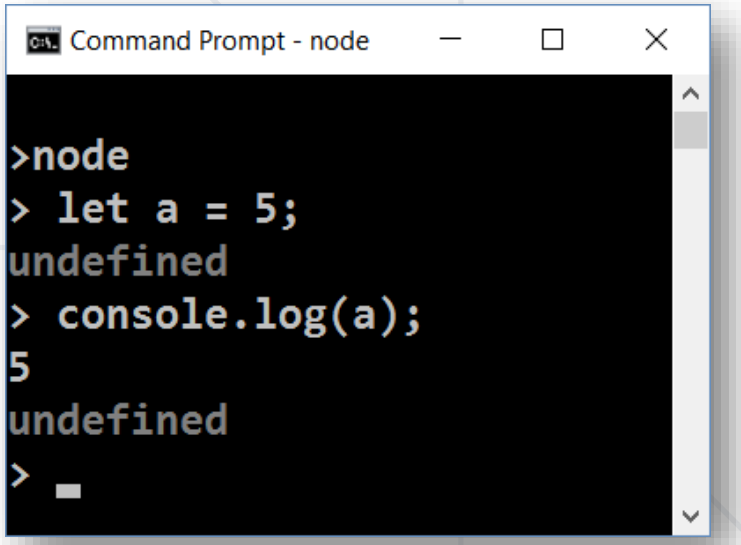
Developer Console: [F12]



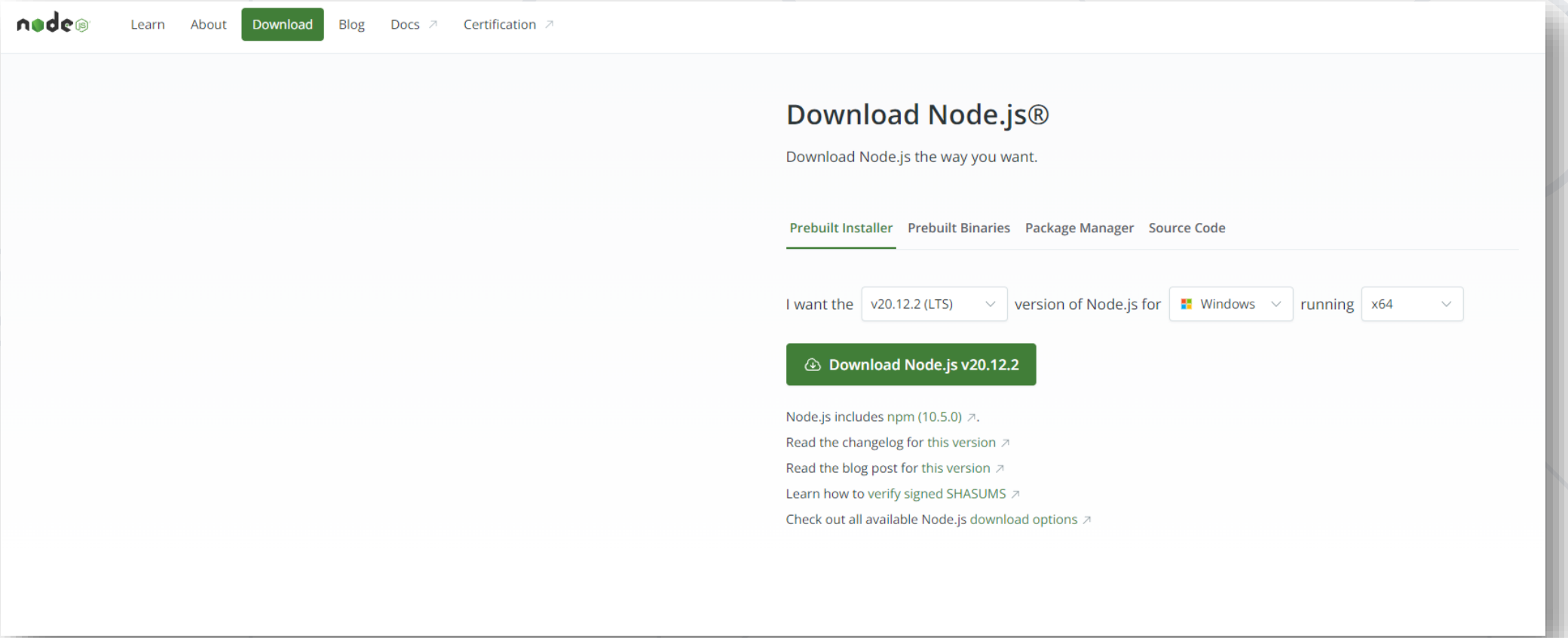


Node.js

- What is **Node.js**?
  - **Server-side** JavaScript runtime
  - Chrome V8 JavaScript engine
  - NPM **package manager**
  - Install node packages

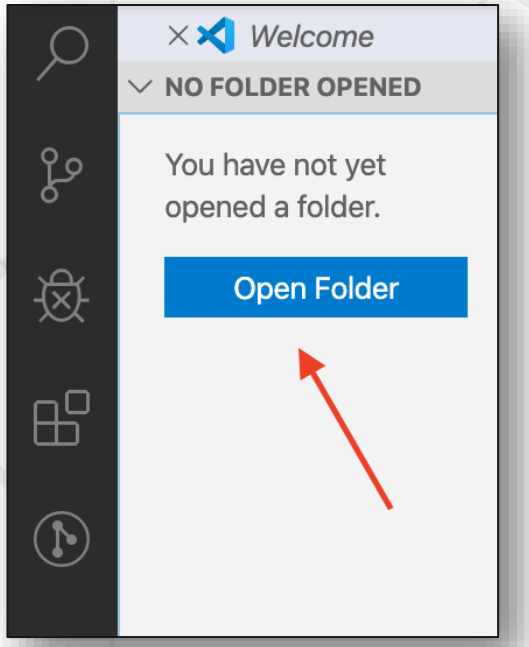


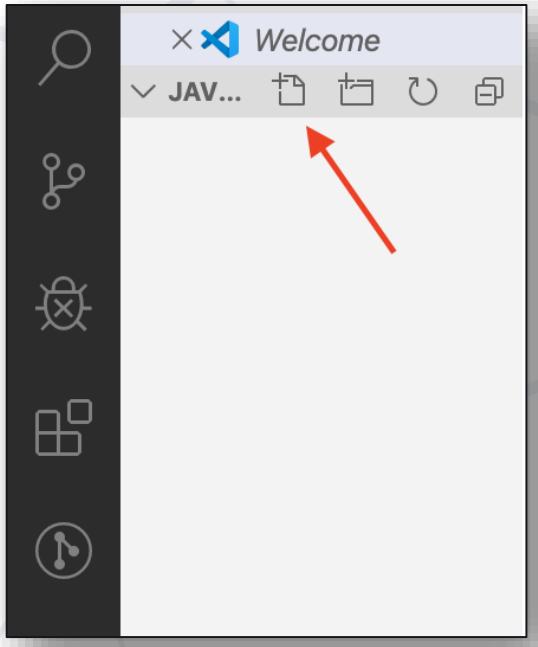
Install the Latest Node.js

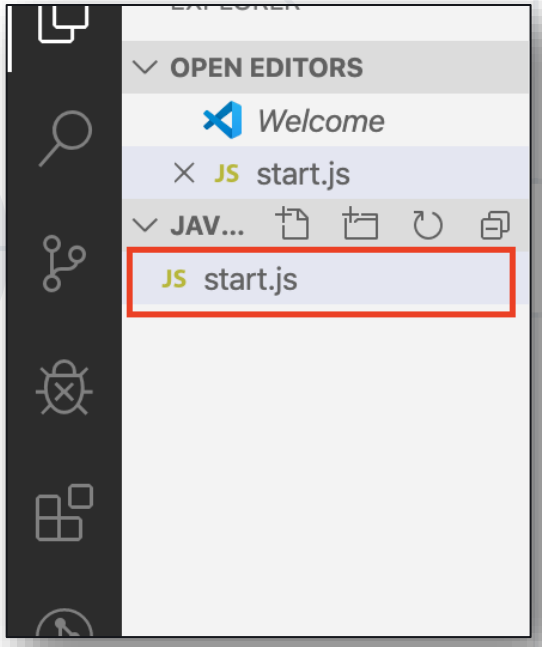


Using Visual Studio Code

- **Visual Studio Code** is powerful text editor for JavaScript and other projects
- In order to create your **first project**:







Data Types & Variables

Identifiers, Declaring Variables, Variable Scope

Data Types

- Seven **data types** that are **primitives**
  - **String** - used to represent textual data
  - **Number** - a numeric data type
  - **Boolean** - a logical data type
  - **Undefined** - automatically assigned to variables
  - **Null** - represents the **intentional absence** of any object value
  - **BigInt** - represent integers with **arbitrary precision**
  - **Symbol** - **unique** and **immutable** primitive value
- **Reference types – Object**

Identifiers

- An **identifier** is a sequence of characters in the code that identifies a **variable**, **function**, or **property**
- In JavaScript, identifiers are **case-sensitive** and can contain Unicode **letters**, **$**, **_**, and **digits** (0-9), but may **not** start with a digit

```
let _name = "John";
```

```
function $sum(x, y) {
    return x + y;
}
```

```
let 9 = 'nine'; //SyntaxError: Unexpected number
```

Variable Values

- Used to **store** data values
- Variables that are assigned a **non-primitive** value are given a **reference** to that value
- **Undefined** - a variable that has been declared with a keyword, but not given a value

```
let a;
console.log(a) // undefined
```

- **Undeclared** - a **variable** that hasn't been declared at all

```
console.log(undeclaredVariable);
// ReferenceError: undeclaredVariable is not defined
```

Variable Values

- `let`, `const` and `var` are used to declare variables
  - `let` - allows **reassignment**

```
let name = "George";
name = "Maria";
```

  - `const` - once assigned it **cannot** be modified

```
const name = "George";
name = "Maria";  // TypeError
```

  - `var` - defines a variable in the function scope **regardless** of block scope

```
var name = "George";
name = "Maria";
```

Legacy Variable Declaration

- You will see **var** used in old examples
- Using **var** to declare variables is a **legacy** technique
- Since **ES2015** keywords **let** and **const** are available
- **var** introduces function scope **hoisting**
  - Will be discussed later in the lesson
- There is no good reason to **ever** use **var**!

Variable Scopes

- **Global scope** – Any variable that's **NOT** inside any **function** or **block** (a pair of curly braces);
- **Functional scope** – Variable declared **inside a function** is inside the local scope;
- **Block scope** – **let** and **const** declares **block** scoped variables

Dynamic Typing

- Variables in JavaScript are **not** directly **associated** with any particular **value type**
- Any variable **can** be assigned (and re-assigned) values of all types

```
let foo = 42;      // foo is now a number
foo = 'bar';       // foo is now a string
foo = true;        // foo is now a boolean
```

- **NOTE: The use of dynamic typing is considered a bad practice!**

Functions

Declaring and Invoking

Functions

- **Function** - named list of instructions (statements and expressions)
- Can take **parameters** and return **result**
  - Function names and parameters use **camel case**
  - The { stays at the same line

```
function printStars(count) {
    console.log("*".repeat(count));
}
```

  - **Invoke** the function

```
printStars(10);
```

Declaring Functions

- Function declaration

```
function walk() {
    console.log("walking");
}
```

- Function expression

```
const walk = function () {
    console.log("walking");
}
```

- Arrow functions

```
const walk = () => {
    console.log("walking");
}
```

Parameters and Returned Value

- You can receive parameters with **no value**
- The **unused parameters** are ignored

```
function foo(a,b,c){
  console.log(a);
  console.log(b);
  console.log(c); //undefined
}
foo(1,2)
```

```
function foo(a,b,c){
  console.log(a);
  console.log(b);
  console.log(c);
}
foo(1,2,3,6,7)
```

- Functions can yield a value with the **return** operator

```
function identity(param){
  return param;
}
console.log(identity(5)) // 5
```

Object Methods and Standard Library

- Any object may have **methods**
  - **Functions** that operate from the **context** of the object
  - Accessed as a **property** using the **dot-notation**

```
let myString = 'Hello, JavaScript!';
console.log(myString.toLowerCase());
// hello, javascript!
```

- JavaScript has a large **standard library**
  - **`Math`**, **`Number`**, **`Date`**, **`RegExp`**, **`JSON`** and more
  - For more information, **visit MDN**

Problem: Echo Function

- A **string argument** is passed to your function
- **Print** on separate lines:
  - The **length** of the input parameter (number of characters)
  - The **unchanged parameter** itself

```
'Hello, JavaScript!'
```

→

```
18
Hello, JavaScript!
```

```
'strings are easy'
```

→

```
16
strings are easy
```

Solution: Echo Function

```
function echo(inputAsString) {
  let stringLength = inputAsString.length;

  console.log(stringLength);
  console.log(inputAsString);
}
```

```
echo('Hello, JavaScript!');
// 18
// Hello, JavaScript!
```

Default Function Parameter Values

- Functions can have **default parameter** values

```
function printStars(count = 5) {
    console.log("*".repeat(count));
}
```

```
printStars(); // *****
```

```
printStars(2); // **
```

```
printStars(3, 5, 8); // ***
```

Operators and Statements

Assignment, Arithmetic, Comparison, Logical

Arithmetic Operators

- **Arithmetic operators** - take numerical values (either literals or variables) as their operands
  - Return a single numerical value
    - Addition (+)
    - Subtraction (-)
    - Multiplication (*)
    - Division (/)
    - Remainder (%)
    - Exponentiation (**)

```
let a = 15;
let b = 5;
let c;
c = a + b; // 20
c = a - b; // 10
c = a * b; // 75
c = a / b; // 3
c = a % b; // 0
c = a ** b;//15^5 = 759375
```

Assignment Operators

- **Assignment operators** - **assign** a value to its left operand based on the value of the right operand

Name	Shorthand operator	Basic usage
Assignment	x = y	x = y
Addition assignment	x += y	x = x + y
Subtraction assignment	x -= y	x = x - y
Multiplication assignment	x *= y	x = x * y
Division assignment	x /= y	x = x / y
Remainder assignment	x %= y	x = x % y
Exponentiation assignment	x **= y	x = x ** y

Problem: String Length

- Receive **three string arguments** as input
- Calculate the **total length** of all strings
- Calculate the **average length**, **rounded down**
- **Print** the result on the console

```
'chocolate', 'ice cream', 'cake'
```

```
22
7
```

```
'pasta', '5', '22.3'
```

```
10
3
```

Solution: String Length

```
function solve(str1, str2, str3) {
  let len1 = str1.length;
  let len2 = str2.length;
  let len3 = str3.length;

  let sumLength = len1 + len2 + len3;
  let averageLength = Math.floor(sumLength / 3);

  console.log(sumLength);
  console.log(averageLength);
}
```

Comparison Operators

Operator	Notation in JS
EQUAL value	==
EQUAL value and type	===
NOT EQUAL value	!=
NOT EQUAL value or type	!==
GREATER than	>
GREATER than OR EQUAL	>=
LESS than	<
LESS than OR EQUAL	<=

Comparison Operators

```
console.log(1 == '1');   // true
console.log(1 === '1'); // false
console.log(3 != '3');   // false
console.log(3 !== '3'); // true
console.log(5 < 5.5);    // true
console.log(5 <= 4);     // false
console.log(2 > 1.5);    // true
console.log(2 >= 2);     // true
console.log((5 > 7) ? 4 : 10); // 10
```

Ternary operator

Conditional Statements

- The **if-else** statement:
  - Do action depending on condition

```
let a = 5;
if (a >= 5) {
  console.log(a);
}
```

If the condition **is met**, the code will execute

  - You can chain conditions

```
else {
  console.log('no');
}
```

Continue on the **next condition**, if the first is **not met**

Truthy and Falsy Values

- "**truthy**" - a value that **coerces** to **true** when **evaluated** in a boolean context
- The following values are "**falsy**" - **false**, **null**, **undefined**, **NaN**, **0**, **0n** and **""**

```
function logTruthiness (val) {
    if (val) {
        console.log("Truthy!");
    } else {
        console.log("Falsy.");
    }
}
```

```
logTruthiness (3.14);       //Truthy!
logTruthiness ({});         //Truthy!
logTruthiness (NaN);        //Falsy.
logTruthiness ("NaN");      //Truthy!
logTruthiness ([]);         //Truthy!
logTruthiness (null);       //Falsy.
logTruthiness ("");         //Falsy.
logTruthiness (undefined);  //Falsy.
logTruthiness (0);          //Falsy.
```

Logical Operators

- && (**logical AND**) - returns the leftmost "**false**" value or the **last truthy** value, if all are true

```
const val = 'yes' && null && false
console.log(val); // null
const val1 = true && 5 && 'yes';
console.log(val1); // 'yes'
```

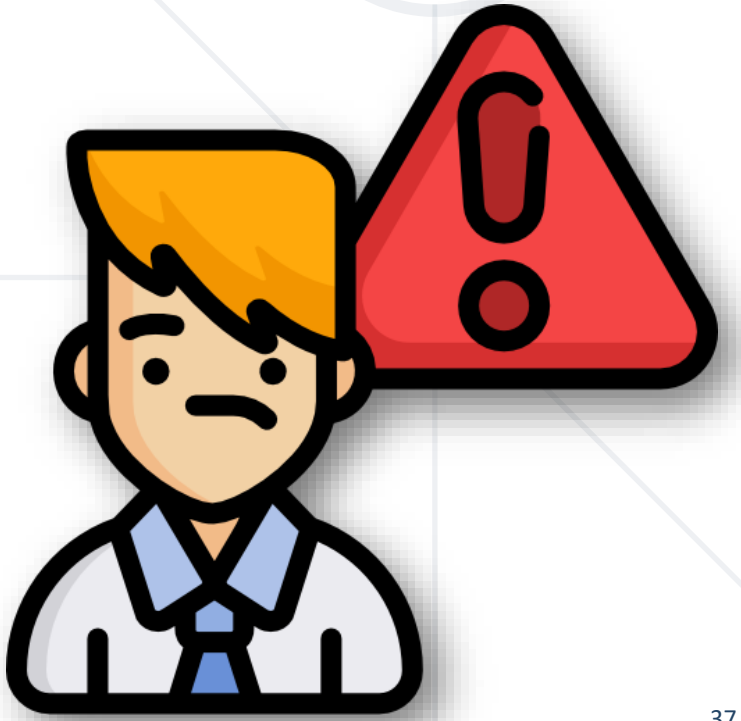
- || (**logical OR**) - returns the leftmost "**true**" value or the **last falsy** value, if all are false

```
const val = false || '' || 5;
console.log(val); // 5
const val1 = null || NaN || undefined;
console.log(val1); // undefined
```

Logical Operators

- ! (**logical NOT**) - Returns **false** if its single operand can be converted to **true**; otherwise, returns **true**

```
const val = !true
console.log(val); // false
const val = !false;
console.log(val); // true
```



Problem: Largest Number

- **Three number arguments** passed to your function as an input
- Find the **largest** of them
- **Print** the result on the **console**

`3, 4, 5`	→	`The largest number is 5.`
`7, 11, 2`	→	`The largest number is 11.`

- **Tip**: Use **interpolated strings** to format the result

```
`3 + 5 = ${3 + 5}` // 3 + 5 = 8
```

Solution: Largest Number

```
function firstSolution(x, y, z) {
    let result;
    if (x >= y && x >= z) {
        result = x;
    } else if (y >= x && y >= z) {
        result = y;
    } else {
        result = z;
    }
    console.log(`The largest number is ${result}.`);
}
```

```
function secondSolution(...params) {
    console.log(`The largest number is ${Math.max(...params)}.`);
}
```

Typeof Operator

- The **typeof** operator returns a string indicating the type of an operand

```
const val = 5;
console.log(typeof val);    // number
```

```
const str = 'hello';
console.log(typeof str);    // string
```

```
const obj = {name: 'Maria', age:18};
console.log(typeof obj);   // object
```

Problem: Circle Area

- Write a function that takes a **single parameter** as an input
- Calculate the **area of a circle**, with the parameter as **radius**
  - If the parameter is **not a number**, print an **error** message
  - Include the **type** of parameter in the message
- **Print** the result on the console, **rounded** to the second decimal

`5`	→	`78.54`
`'name'`	→	`We can not calculate the circle area, because we receive a string.`

Solution: Circle Area

```
function solve(radius) {
  let inputType = typeof(radius);

  if (inputType === 'number') {
    let area = Math.pow(radius, 2) * Math.PI;
    console.log(area.toFixed(2));
  } else {
    console.log(`We can not calculate the circle
    area, because we receive a ${inputType}.`);
  }
}
```

Some Interesting Examples

- Data Types

```
console.log(typeof NaN);                    //number
console.log(NaN === NaN);                   //false
console.log(typeof null);                   //object(legacy reasons)
console.log(new Array() == false);          //true
console.log(0.1 + 0.2);                     //0.30000000000000004
console.log((0.2 * 10 + 0.1 * 10) / 10); //0.3
```

- Truthy and Falsy values

```
const variable = [];                          //empty array
console.log(variable == false);             //evaluates true
if (variable) { console.log('True!') }; //'True!'
```

Loops

- The **for** / **while** loops work as in C++, C# and Java
- Classical **for**-loop

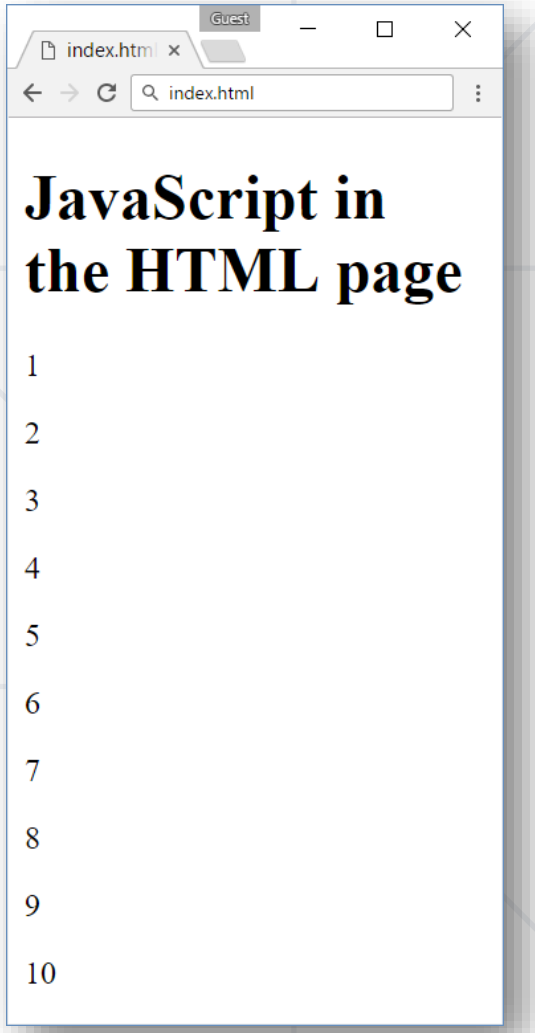
```
for (let i = 0; i <= 5; i++) { console.log(i); }
// 0 1 2 3 4 5
```

- JavaScript supports two more variants of the **for**-loop:
  - **for-of** – used with arrays and iterators
  - **for-in** – used with objects and associative arrays
  - Both will be reviewed in **upcoming lessons**

Mix HTML and JavaScript

Mixing HTML + JavaScript

```
<!DOCTYPE html>
<html>
<body>
  <h1>JavaScript in the HTML page</h1>
  <script>
    for (let i=1; i<=10; i++) {
      document.write(`<p>${i}</p>`);
    }
  </script>
</body>
</html>
```



Sum Numbers with HTML Form

```html
<form>
  num1: <input type="text" name="num1" /> <br>
  num2: <input type="text" name="num2" /> <br>
  sum: <input type="text" name="sum" /> <br>
  <input type="button" value="Sum" onclick="calcSum()" />
</form>
```

```js
function calcSum() {
  let num1 = document.getElementsByName('num1')[0].value;
  let num2 = document.getElementsByName('num2')[0].value;
  let sum = Number(num1) + Number(num2);
  document.getElementsByName('sum')[0].value = sum;
}
```

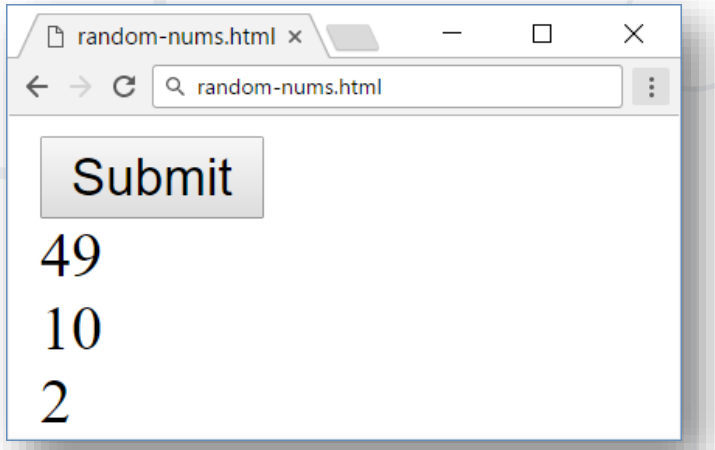
Load JavaScript File from HTML Document

random-nums.html

```html
<!DOCTYPE html>
<html>
<head>
  <script src="numbers.js">
  </script>
</head>
<body>
  <input type="submit"
onclick="printRandNum()" />
</body>
</html>
```

numbers.js

```js
function printRandNum() {
  let num = Math.round(
    Math.random() * 100);
  document.body.innerHTML +=
    `<div>${num}</div>`;
}
```



Debugging Techniques

Strict Mode, IDE Debugging Tools

Strict Mode

- **Strict mode** limits certain "sloppy" language features
  - Silent errors will **throw Exception** instead

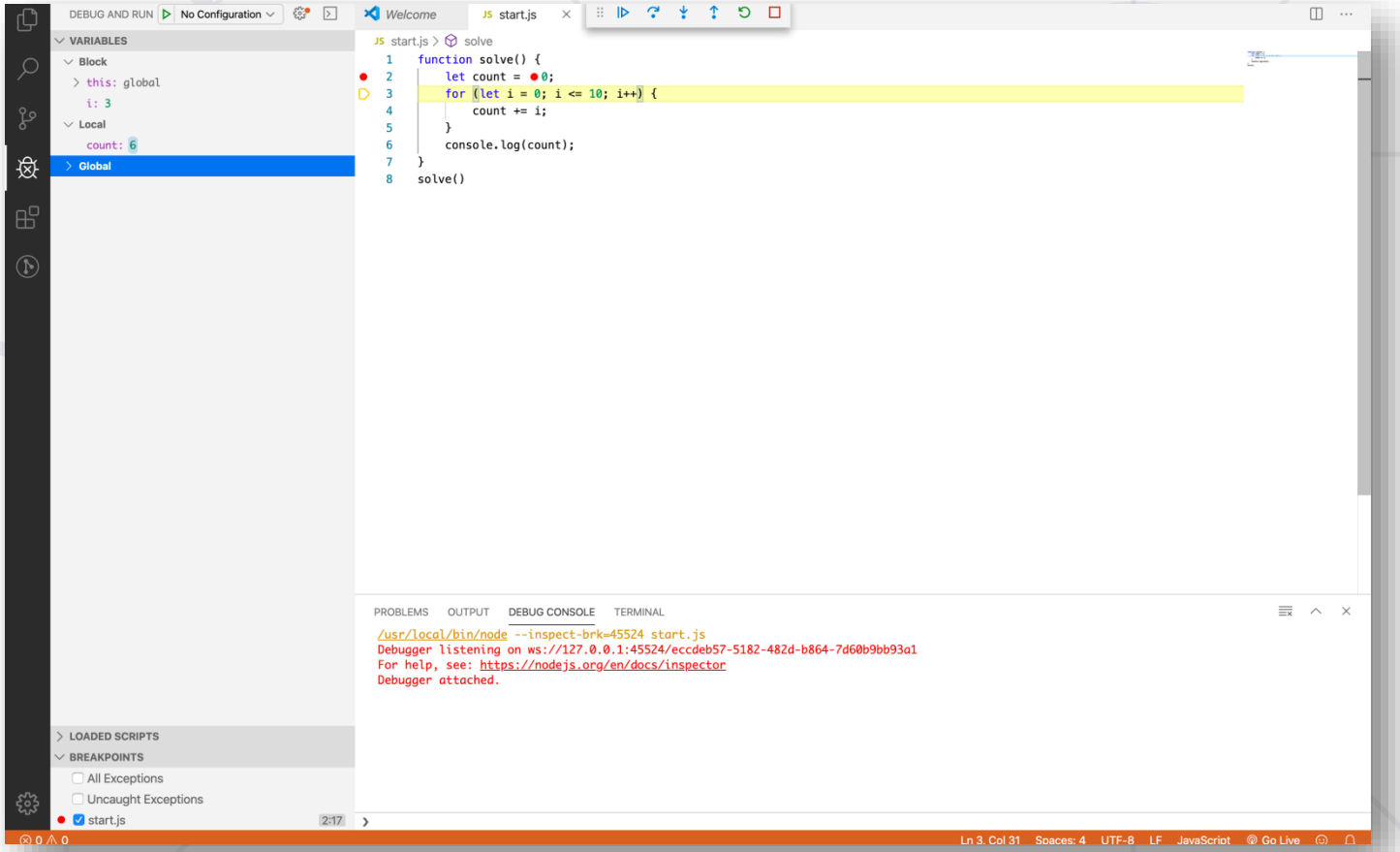
```
'use strict';                // File-level
mistypeVariable = 17; // ReferenceError
```

```
function strict() {
    'use strict';            // Function-level
    mistypeVariable = 17;
}
```

- Enabled by default in **modules**

Debugging in Visual Studio Code

- Visual Studio Code has a built-in **debugger**
- It provides:
  - **Breakpoints**
  - Ability to **trace** the code execution
  - Ability to **inspect** variables at runtime



Using the Debugger in Visual Studio Code

- Start without Debugger: **[Ctrl+F5]**
- Start with Debugger: **[F5]**
- Toggle a breakpoint: **[F9]**
- Trace step by step: **[F10]**
- Force step into: **[F11]**

Language Specifics

Type Coercion, Functions and Scope

First-class Functions

- First-class functions – a function can be passed as an **argument** to other functions
- Can be **returned** by another function and can be **assigned** as a value to a variable

```
function running() {
    return "Running";
}
function category(run, type) {
    console.log(run() + " " + type);
}
category(running, "sprint"); // Running sprint
```

Callback function

Nested Functions

- Functions can be **nested - hold other functions**
  - Inner functions have **access** to **variables** from **their parent**

```
function hypotenuse(m, n) { // outer function
    function square(num) {  // inner function
        return num * num;
    }
    return Math.sqrt(square(m) + square(n));
}
```

3, 4 → 5

Hoisting

- Variable and function declarations are **put into memory** during the **compile** phase, but stay exactly where you **typed** them in your code
- **Only declarations are hoisted**

Hoisting Variables

```
console.log(num); // Returns undefined
var num;
num = 6;
```

```
num = 6;
console.log(num); // returns 6
var num;
```

```
num = 6;
console.log(num); // ReferenceError: num is not defined
let num;
```

```
console.log(num); // ReferenceError: num is not defined
num = 6;
```

Hoisting Functions

```
run(); // running
function run() {
    console.log("running");
};
```

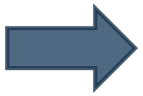
```
walk(); // ReferenceError: walk is not defined
let walk = function () {
    console.log("walking");
};
```

```
console.log(walk); //undefined
walk(); // TypeError: walk is not a function
var walk = function () {
    console.log("walking");
};
```

Problem: Aggregate Elements

- Create function that applies **sum**, **inverse sum** and **concatenation**
  - Try to use a **nested aggregating function**
- Input will be an **array** of numbers
- **Print** the result on **separate lines** on the console

```
[1, 2, 4]
```



```
7   // sum:     1 + 2 + 4
3.5 // inverse: 1/1 + 1/2 + 1/4
124 // concat:  '1' + '2' + '4'
```

Solution: Aggregate Elements

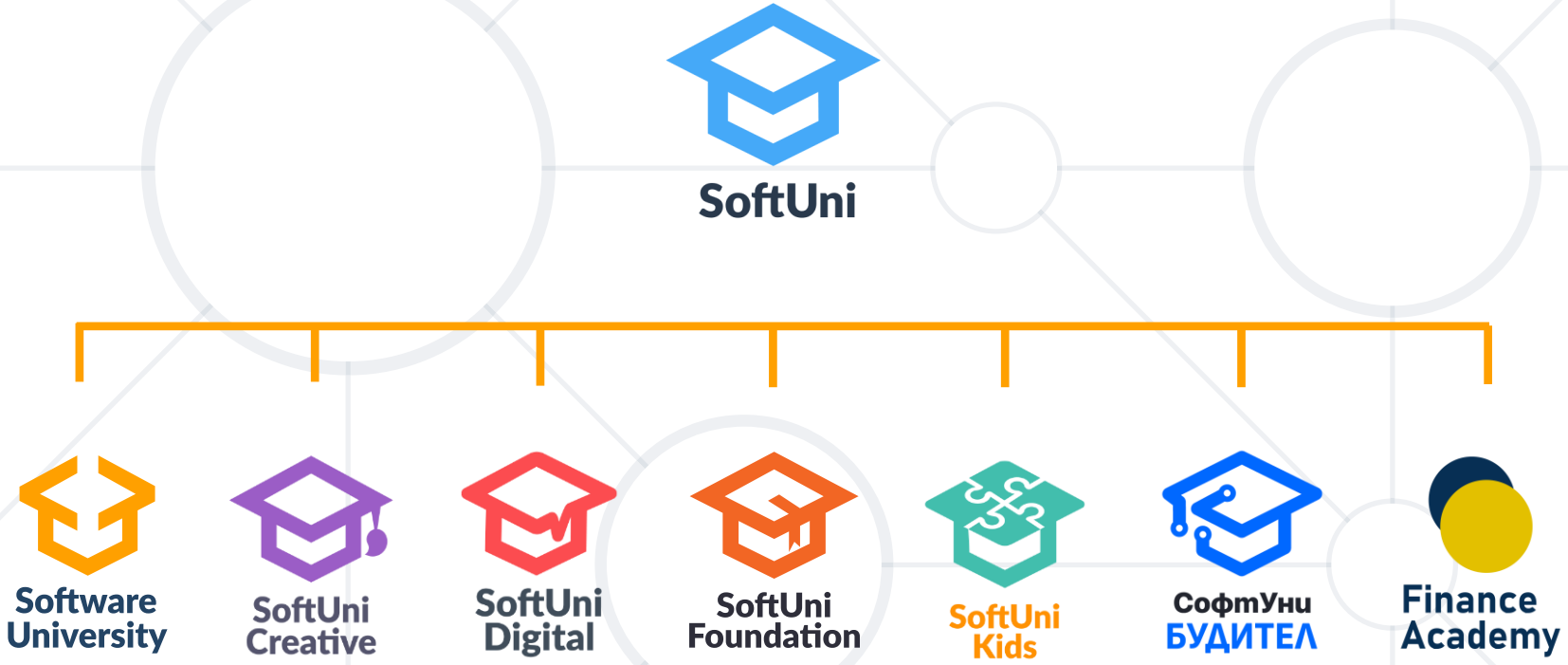
```
function aggregateElements(elements) {
    aggregate(elements, 0, (a, b) => a + b);
    aggregate(elements, 0, (a, b) => a + 1 / b);
    aggregate(elements, '', (a, b) => a + b);

    function aggregate(arr, initVal, func) {
        let val = initVal;
        for (let i = 0; i < arr.length; i++)
            val = func(val, arr[i]);
        console.log(val);
    }
}
```

Summary

- JavaScript is a multi-paradigm language
- Variables are used to store data references
  - `let`, `const` and `var` are used to declare variables
- Arithmetic operators take numerical values as their operands
- Functions can:
  - Take parameters and return result
  - Hold other functions inside them

Questions?



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